

CHROMEBOOKS AS LEARNING TOOLS IN THE SCIENCE CLASSROOM

by

Lenora Ann Bostic

A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2017

©COPYRIGHT

by

Lenora Ann Bostic

2017

All Rights Reserved

DEDICATION

I dedicate this paper to my beautiful niece, who is the light of my life and my number two daughter. I love you kid! Thank you for all your awesome help and suggestions through this project, it means more than you know.

Also, to my husband, children and grandchildren who have sacrificed time with their wife, mother and grandmother over the years so I could meet my education goals. Thank you and I love you more than you realize.

TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND	1
2. CONCEPTUAL FRAMEWORK	4
3. METHODOLOGY	8
4. DATA AND ANALYSIS	16
5. INTERPRETATION AND CONCLUSION	28
6. VALUE	33
REFERENCES	36
APPENDICES	39
APPENDIX A Pre-Study Survey.....	40
APPENDIX B Post-Study Survey	44
APPENDIX C Study Interview Questions	48
APPENDIX D Institutional Review Board Approval	50
APPENDIX E Additional Figures	52
APPENDIX F Student Distraction Tally Sheet	57

LIST OF TABLES

1. Research Matrix	16
--------------------------	----

LIST OF FIGURES

1. Chromebook Program Excitement.....	17
2. School Helping Me with Program (Appendix E)	53
3. Preparation for College (Appendix E)	53
4. Benefit to Learning (Appendix E)	54
5. Positive Addition to School (Appendix E)	54
6. Non-treatment vs. Treatment Test Scores.....	19
7. Assignment Due Dates.....	21
8. Due Date Adherence Paper vs. Electronic Submission	23
9. Improved Attention	24
10. Not Paying Attention (Appendix E)	55
11. Perceived Distraction Rate.....	25
12. Benefit to Science Class Learning	55
13. Science Assignment Due Dates	56

ABSTRACT

This action research study explored elements of interest during the implementation of a one-to-one Chromebook program in a 425 student public high school. In particular, student interest and perceptions of the program, gains in learning during usage of a flipped classroom format, digital homework submission relevant to assigned due dates and student distraction during class were evaluated. Teacher ability to provide adequate feedback in a timely manner to students was also evaluated.

Student interest and perceptions were positive, while gains in learning were minimal overall with unproven indications that females benefitted more than males from the flipped format. Worsening of homework submission was noted, with implications that factors other than digital submission were the cause. Students being distracted by the devices during class was noted with no definitive indicator being identified. However, improved teacher satisfaction was noted in the areas of providing feedback to students and usage of the devices for learning.

INTRODUCTION AND BACKGROUND

In the spring of 2015, the principal at River Valley High School (RVHS) informed staff members teaching content courses for senior students, that a pilot one-to-one Chromebook program would be implemented in August of the 2015-2016 school year. The principal provided each staff member with a Chromebook for personal use, with the expectation they would use the devices to become familiar with Google Classroom and the rest of the Google suite of programs. The classes I taught, that were affected by this one-to-one pilot program were physics and advanced chemistry. Since this generation of students grew up with technology available since a very early age, the ability to have a personal computing device available for academic use had spurred a great deal of conversation and research.

One challenge RVHS routinely faced was the lack of adequate computer lab space and computers for use by students during the school day. There was a computer lab attached to the RVHS library, which contained 30 desktop computers. These computers were obtained over the course of several years, so the brands and versions of Microsoft suite of programs was not consistent. Some classrooms contained older desktop computers located at the rear of the rooms; however, none contained more than four per classroom, which made it difficult for teachers to incorporate technology into their lessons. In response to the obvious technology need at RVHS the principal spent two years planning for this pilot program.

River Valley High School is one of seven schools in the Gallia County Local School District. It is located in southeastern Ohio near the West Virginia state border.

This is a rural, low-income area of Ohio that is considered Appalachia. Several stereotypical components of Appalachia manifest in this district. The district encompasses over 450 miles of county and township roads serving the north and south areas of the county. The two areas of the district, referred to as north and south, are separated by the village of Gallipolis. Gallipolis is the county seat, which is served by a separate school district. Approximately 1,600 students are served by the school district with an average of 425 enrolled in grades 9-12 at RVHS during the 2016-2017 academic year. Since over 60% of students meet federal poverty guidelines, the district is currently participating in a grant program that provides free breakfast and lunches to all students. A full 100% of the students are classified as economically disadvantaged. The majority of the student population is Caucasian with less than 5% self-identifying as African American, Latino/Hispanic or other. There are only two to four English Language Learners (ELL) each school year, as a part of our foreign exchange program.

The one-to-one pilot program was initially designed and implemented by the principals at RVHS and one of the district's elementary schools as part of their joint capstone project for the doctorate of education degree (Bostic and Edwards, 2016). This program was initially designed for seniors and if deemed successful, would grow to include juniors the following year. A pilot program that provided a classroom set of Chromebooks to the fourth and fifth grade Math and English classes at an elementary school ran concurrent to this senior Chromebook program. Preparations for the program included the purchase of 85 Chromebooks for RVHS: 75 for the senior students and 10 for the senior course teachers. Wi-Fi capabilities at the school had been upgraded the

previous year and were determined to be sufficient to support the increased need. Senior course teachers were provided with professional development during the spring and summer of 2015. The expectation was that these teachers would use and understand the Google suite of programs available for use on the devices. The program was such a success the first year that it was expanded during the 2016-2017 school year to the whole district, not just the juniors at RVHS. All elementary classrooms are now supplied with classroom carts containing devices for use during the school day. Middle school students have assigned devices that are devoted for their individual use each school day, but they must sign the device out if they need to complete work at home. All high school students have an assigned device that they take ownership of for the academic year and may carry to home and school each day for use at any time they need.

The following costs were incurred during the second year of the program at RVHS:

- 1,350 Chromebooks at \$224 each: \$302,400
- 9 Carts at \$1,245 each: \$11,205
- 850 12" protective cases at \$26.50 each: \$22,525
- Additional repair expenses for 4.3% of the previous purchased units (T. Boothe, personal communication, February 3, 2017).

The purpose of this action research study was to assess the effects of one-to-one Chromebook use for all students in advanced science classes during the 2016-2017 year. The study focused on various issues regarding whether student attitudes towards school, skills, and learning improved when they had the advantage of personal technology at their

fingertips. During this action research study, students had access to the Chromebooks during the school day and at home for the entire school year. The program would be considered successful in science courses if it positively impacted student's skills and learning.

The primary action research study question was:

- How will a one-to-one Chromebook program impact student learning, skills and attitudes towards school and science?

Secondary questions included:

- How can implementing a flipped class using Google classroom in science courses improve science learning?
- How will student adherence to due dates be effected when assignments are submitted digitally vs. on paper?
- How will using Google classroom and applications for assignments impact the teacher's ability to provide adequate feedback on assignments?
- How often will using the Chromebooks in class provide a distraction from learning, if students also have access to the internet during class?

CONCEPTUAL FRAMEWORK

In the last several years, as technology use culturally has increased, there has been a push to include technology in teaching and learning. As technology use has increased culturally, the cost for this technology has steadily decreased. This has afforded educators the ability to slowly but continually add to the amount of technology incorporated into their classrooms and curriculums. As a result of this changing culture,

there has been a significant amount of research around the pros and cons of technology use in the classroom. Also, there is a direct correlation between the increases in technology use culturally and the expectation that college students will have advanced technology skills and be able to participate in digital learning. Employers also expect new employees to enter the workforce with 21st Century skills, including critical thinking, problem solving, collaboration and teamwork abilities as well as creativity and imagination.

Most of the students who participated in the one-to-one Chromebook study entered the study with existing technology skills. However, most of the technology skills that these students had were through gaming, social media and smartphones. The students had never truly engaged in a structured technological experience. Students preferred to use technology whenever possible and consequently educators have attempted to use the existing technology habits of their students to make a more productive experience for all.

Many studies have been conducted regarding various aspects of the use of technology in the classroom. Several of these, regardless of the aspect being investigated have noted an improved attitude towards school or science. During a study on performance and attitudes towards chemistry after employing a flipped classroom model, Olakanmi (2016) found improved attitudes towards chemistry as well as improved performance. In another study regarding flipped instruction in a high school science class, Leo and Puzio (2016) noted that students in a non-treatment classroom were somewhat envious of those in the treatment classroom due to the style of learning. As an

added benefit Lux, Bangert, McGeehan, Will-Dubyak and Watson (2015), in their study of a program involving class sets of devices, found influences on student learning and teacher practice, as well as a decrease in school days missed by elementary students in the pilot classrooms after implementation of class sets of devices.

An increasingly common education structure mentioned above is the flipped classroom model first demonstrated and reported by Eric Mazur. A flipped classroom does not involve a single instructional method. It is a variety of techniques used differently by each teacher (Leo, Puzio, 2016) with a common denominator-technology use. In a traditional classroom model, content is presented in class and the practice happens as homework. Most often, in the flipped classroom model, the content is presented as homework through interactive units and videos, the practice happens in the classroom through open discussion and classroom activities. Various studies have explored multiple benefits of the flipped classroom. Lage, Platt, and Treglia (2000) in a study at Miami University involving undergraduates in a flipped type of course explained that this style of classroom provides a “strategy of teaching that engages a wide spectrum of learners.” An 18 week study to evaluate the effects of a flipped classroom strategy in a high school AP Chemistry course showed a statistically significant difference in learning based on test scores from treatment versus non-treatment groups (Schultz, Duffield, Rasmussen and Wageman, 2014).

Vanderkam (2013) believes we need more classrooms employing technology and the resulting learning pedagogy to improve student growth and teacher satisfaction while educators who previously found it difficult to reach certain students are embracing

technology as another resource. Tucker (2013) found that “Teachers are able to adapt the flipped approach to both their budget and their students, which in turn, makes it a dynamic way to address the needs of a particular culture, a particular class, and even a particular student.”

The implementation of a successful education model needs not only the buy-in of its teachers, but also the buy-in of its students. The student’s perception of their learning experience is as important, if not more so, than other measurable benefits. Sparks (2011) in discussing flipped classrooms in Georgia stated that improved student engagement and accountability are critical to the success of a flipped classroom because a flipped format requires students to perform more work on their own. However, researchers including Tucker (2013) have discovered that “students were open and receptive to the approach of reconstructing the classroom following a flipped model.”

In particular, in the science classroom Moore (2012) noted there were “obvious advantages to the use of virtual learning environment for laboratory science instructions.” She also concluded that “students found both physical and virtual experiences to be a great value.”

Although in a flipped classroom, what previously was homework becomes classwork, this work has a purpose, which is traditionally to provide practice and enrichment of the skills or content taught. Most teachers have struggled at one time or another with getting their students to perform the homework assigned. Consequently, homework has been a popular topic for investigation for 50 years or more.

In their synthesis of homework research Cooper and Valentine (2001) found that high school students who completed homework scored approximately two thirds of a standard deviation higher than those who didn't resulting in a correlation between higher achievement and the completion of homework. They also found that studies showed this relationship didn't manifest until study subjects reported a minimum of one hour of homework per week and peaked at a reported two hours of homework a week.

Xu (2011) in his study of homework completion and factors affecting it, found that six variables at the individual level contributed to the amount completed. These included gender, interest, management skills and perceptions of the teacher feedback being provided on the completed work.

A common misconception about the use of technology in the classroom is that it will be a great distraction to the students and teachers. Zadok and Tal (2015) however, found a significant reduction in the amount of distractive usage of mobile devices such as smartphones, tablets and laptops by students when the instructor incorporated these devices into curriculum constructively

METHODOLOGY

During the course of this research study, several groups of students were studied. The pre and post study surveys (Appendix A and B) about the Chromebook program were delivered to all students at RVHS via a Google Forms document. This included 425 students in grades 9-12. More specific data regarding assignment due dates and teacher feedback were collected from my advanced science courses taught during the 2016-2017 academic year. These courses included one physics class of 13 seniors and 1 junior,

comprised of 10 females and 4 males along with one advanced chemistry class of six senior students included four males and two females. Test scores and observations on distraction were collected from four chemistry classes with a total of 48 students. These involved 45 juniors and 3 seniors. There were 22 males and 26 females in these chemistry classes. Student interviews (Appendix C) represented a cross section of students from all six courses.

Treatment

Determination of the effect of a flipped classroom using Google classroom for delivery of the home study material was achieved by studying test results from two content units delivered consecutively. The first unit on ionic and metallic bonding was presented using the teacher's normal delivery method, which included various traditional techniques. Fifteen class periods were used for this unit including two periods for students to complete the written unit test. Class periods were 52 minutes in length during the study period. Typically each class period included 10-15 minutes of lecture or discussion with the inclusion of Power Point presentations or hand written notes presented on the large whiteboard in the classroom. At times an older model transparency projector was used to display learning materials as well. Students were given assignments daily that reiterated the key points of the daily topic. Examples of these assignments might be questions from the textbook or an individual worksheet. At other times, the task was to work a problem in groups of two on whiteboards measuring two feet by three feet. Students were then given 10-20 minutes to complete the assignment, while the teacher circulated through the room to assist as needed. Assistance

provided often included repeated explanations of the topic, as well as, answering questions regarding completion of the assignment. After 10-20 minutes, one of several things occurred; the teacher checked each student's work for a completion grade and reviewed the correct answers, the students were instructed to complete the assignment at home if the majority had not done so in class or the students presented their whiteboard in a discussion circle. On one occasion, the student work was collected for more in depth evaluation by the teacher. Each period concluded with a wrap-up discussion including time for questions or a written formative assessment.

Three days were used for teaching ion formation, including how positive and negative ions form, how electron configuration relates to ion formation and ion bond formation. Four days involved learning about ionic bonds and ionic compounds, which included the topics of crystal lattice structures, relationship between bond strength and compound properties, and exothermic/endothermic bond formations. Also, the fourth day of the unit included a vocabulary quiz, which students prepare for by writing out the definitions for the given words and memorizing them at home. No practice for this quiz is done during class time. An additional three days covered the topics of names and formulas of ionic compounds, including formula units and compound composition, writing formulas and balancing charges for ionic compounds, and naming guidelines for ionic compounds and polyatomic ions. Finally, two days were devoted to topics regarding metallic bonding and properties of metals. These topics included metallic bond characteristics, electron sea model and alloys. The eighth day of the unit was used for a quiz over the first two sections, ion formation and ionic bonds and compounds. The final

two days of the unit started with a 20 minute question and answer review time, then students started the first 10 questions of the test. The final day of the unit was used for the completion of the remaining 20 test questions. The 15 days for this unit was interrupted by one free period when the majority of students were attending an academic extracurricular function.

The treatment unit was presented in a “flipped” manner involving the same total number of days and class periods. Two days were used for teaching the covalent bond including topics regarding the octet rule, multiple bonds and bond strength. The next two days were devoted to naming molecules including rules for binary molecular compounds, binary acids and oxyacids. Five days were allotted for molecular structure topics including Lewis structures, resonance, structures exhibiting exceptions to the octet rule, VSEPR bonding theory, hybridization and molecular shapes. The final day was devoted to electronegativity and polarity including polar and non-polar covalent bonds and characteristics of covalent compounds. Again, a vocabulary quiz was given on the third day of the unit and a five question content quiz was given at the beginning of day seven. The final two days followed the same format as the ionic unit with the first 20 minutes devoted to a question and answer review time followed by the start of the first 10 questions of the test. The final day was used to complete the remaining 20 test questions.

This unit was interrupted three times by free periods when the majority of students were attending various external academic activities that extended the unit over a four week time period rather than a continuous 15 school days.

This unit was a flipped classroom model, because the homework for this unit included topic related videos assigned in Google classroom. The various videos were retrieved from www.Bozemanscience.com, www.khanacademy.com and from a series of podcasts provided on cd to me by a colleague. Each day that videos were assigned for homework there were no more than two videos with a maximum play time of 25 minutes. This was followed the next day by an in class activity involving the video topic. Activities used in class to support learning of the content included worksheets, white boarding and kinesthetic activities.

The research methodology used during this AR project received an exemption by Montana State University's Institutional Review Board (IRB) and compliance for working with human subjects was maintained (Appendix D).

Instrumentation

The devices for this study were implemented in the second month of the academic year. At the time data collection started for the study, all students had acquired basic skills with the Chromebooks and the Google applications from use in other courses. This included creating, saving, sharing and editing documents in various Google applications and submitting assignments through Google Classroom, as well as communicating with teachers via Gmail.

Several methods of data collection were employed during the course of the research. This research included surveys, group and individual interviews, statistical data collection and calculation plus observations. I used smaller samples of one to three students for individual and small group interviews. Larger sample sizes were used for

surveys and some statistical data collections. Observations included whole classes of 6-25 students depending on course and grade level of students. Data and sampling occurred during the first semester and continued into the second semester dependent upon the findings and need for additional data.

A researcher developed pre-study survey regarding the Chromebook program was administered to all students at RVHS, using the Google Forms application during the first week of September 2016 (Appendix A). This survey included questions regarding student perceptions about the one-to-one program, benefits of having a personal computing device available, study skills, note taking abilities and distractions caused by having a device available in class. A post-study survey was administered in February of 2016 and March of 2017 to the same groups of students (Appendix B). The post survey was also researcher developed and designed to evaluate perceptions of the same indicators after six months of incorporating the devices into the curriculum.

Students were asked to volunteer for individual and group interviews (Appendix C) regarding their motivation, thoughts on meeting due dates, ability to learn technology and interest in science classes. These students were not offered any incentive to participate in the interviews. In fact, participation involved sacrificing a study hall period. Six senior students were interviewed in one small group interview and three individual interview sessions. Interviews were conducted in the science classroom, where students were already comfortable. All interviews were audio recorded, transcribed and student anonymity maintained in the transcriptions.

Late assignments was a continuous problem in science courses. Since late assignments are not an acceptable habit in college, this issue needed to be addressed with the juniors and seniors. The classroom policy regarding homework included a late policy which gave students three days past the due date for turning in assignments. Each day an assignment was late would result in a 25% reduction of the grade earned. After the fourth day, no credit was received for the assignment and a zero recorded in the gradebook. A system was in place for recording the number of days an assignment was late, so reviewing and gathering statistical data on late assignments from previous years was easily obtained. I had maintained a written gradebook for the previous six years of teaching and still possessed these historical records for statistical review. This was then compared to the due date information from the Google Classroom application used for submitting assignments on the Chromebooks. The Google Classroom application allowed me to set a due date and time. If the assignment was late, the student could still submit it, but I could retrieve the day and time submitted, which allowed for the number of days late to be calculated. These results were then compared to the results for the same students from the previous year. Eleven junior students from chemistry during the 2015-2016 academic year were seniors in the physics course during the 2016-2017 year when the program was expanded. These students included eight females and three males. All were in the top twenty percent of the senior class with five attempting physics because it was considered a pre-requisite for their planned college major. Six students were attempting physics in order to earn an honors diploma designation at their anticipated graduation in May 2017. The number of late assignments for these 11

students during both academic years was recorded. The number of assignments that were never turned in was also recorded. Percentages in each category were calculated and compared for late or missing only. The time frame for data from the 2015-2016 academic year in their chemistry course was September 15, 2015 through May 15, 2016. Data was collected for the 11 students during the time frame of October 1, 2016 through February 1, 2017 while these same students were seniors in physics.

Collection of data regarding students' distraction by the Chromebooks and internet availability during class was evaluated using an impartial staff member of RVHS referred to as Ms. Doe. The staff member was invited to observe four periods of chemistry classes on three different days during the period from December 1, 2016 through February 1, 2017. Ms. Doe circulated through the room during the class period. She was provided with a tally sheet (Appendix F) where she recorded at three minute intervals, how many students were on task with the required work, how many were working on a different assignment and how many were on an unrelated internet website. A teacher journal was also compiled from notations and observations recorded in the lesson planning log maintained. Data collection techniques for each study sub-question are shown in Table 1.

Table 1
Research Matrix

“How will a one to one Chromebook program impact student learning, skills and attitudes towards school and science?”	Survey –Pre and post study Google Forms survey of student perceptions of program and learning	Student interview questions regarding use of the technology	Observations-teacher observations of student technology use
How can implementing a flipped class using Google classroom in science courses improve science learning?	Graded artifacts of unit tests from non-treatment unit versus treatment unit		
How will student adherence to due dates be effected when assignments are expected to be submitted digitally vs. on paper?	Statistics of compliance from 2015-2016 vs. 2016-2017 academic year from 11 students from grade books versus Google classroom	Surveys-pre and post study Google forms survey questions regarding students habits regarding due dates	Interviews-regarding student self-perceived habits.
How often will using the Chromebooks in class provide a distraction from learning, if students also have access to the internet during class?	Statistics from three observations		
How will using Google classroom and applications for assignments impact the teacher’s ability to provide adequate feedback on assignments?	Teacher journal reflections		

DATA AND ANALYSIS

The primary study questions was “How will a one to one Chromebook program impact student learning, skills and attitudes towards school and science?” Data collected in reference to students attitudes towards school and science were gathered from the surveys given pre and post study. From the 425 students enrolled at RVHS during the course of the study, the numbers of students responding to the surveys was very similar

with an average of 216 (50.8%) answering each question on the pre-study survey and 225 (52.9%) answering all questions on the post-study survey.

The majority of students expressed excitement about the opportunity provided by the Chromebook program with 80.1% expressing degrees of agreement that they were excited about the program pre-study. However, post-study responses indicated this had dropped to 66.7% by March of 2017 (Figure 1).

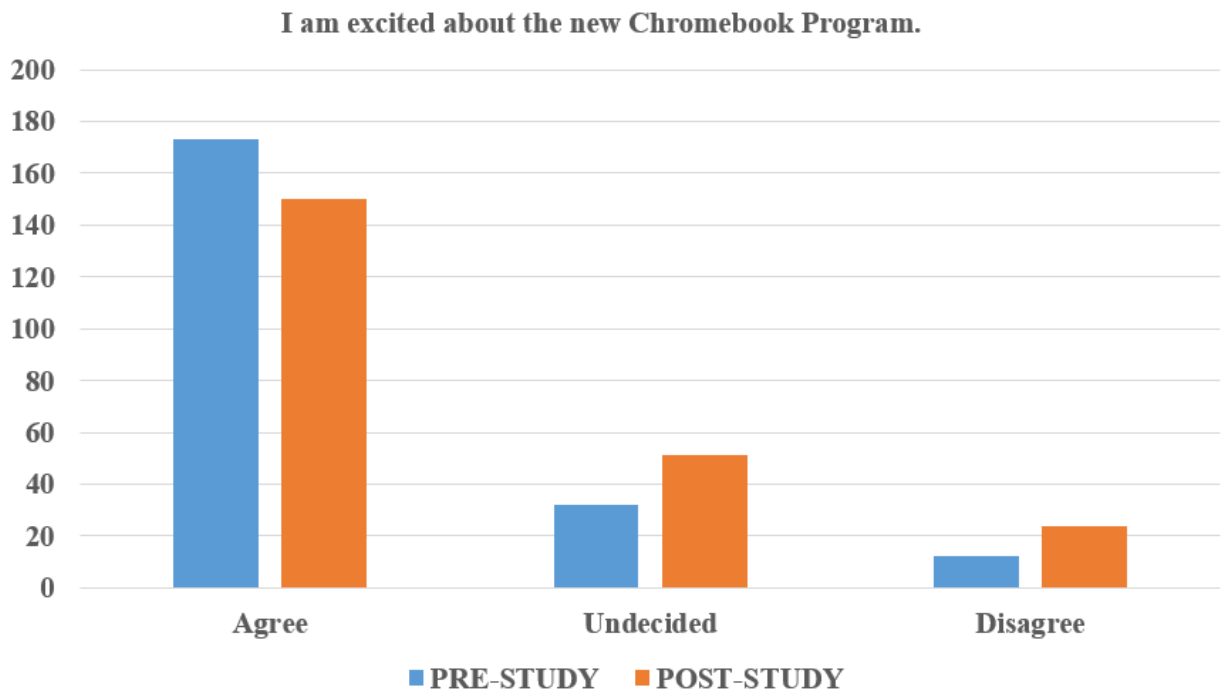


Figure 1. Chromebook program excitement, (Pre-study $N=216$, Post-study $N=225$).

In response to questions regarding whether the school was helping the students by starting the Chromebook program, 84.6% agreed on the pre-study survey but again this dropped on the post-study survey to 79.1% (Appendix E, Figure 2).

Students also agreed in that having the experience with a personal computer would help to prepare them for a career with 81.4% in agreement pre-study and 73.3%

post-study. Although the percentage in agreement about preparation for a career went down on the post-study survey, the percentage increased regarding preparation for college from the pre-study survey of 74.7% to post-study of 75.1% an increase of 0.4% (Appendix E, Figure 3).

Students were also surveyed regarding whether the devices would benefit their learning in science classes. Only 68.4% of students agreed during pre-study polling with a decrease to 57.3% in agreement on the post-study survey. However, 80.1% agreed when asked the question about benefitting learning in all classes during the pre-study. Post-study numbers indicated 64% still agreed with the statement that the Chromebooks would benefit learning in all their classes (Appendix E, Figure 4).

Finally, students were asked about the program being a positive addition to the school's curriculum to which they agreed 86.2% of the time on the pre-study survey but again dropped on the post-study to 77.3% (Appendix E, Figure 5).

Although three of the four questions garnered a decreased number of students in agreement on the post-study survey, more than 65% of the student population represented were still in agreement with the statements indicating assumed positive perceptions of the program and its benefits.

Evaluation of the sub question "How can implementing a flipped class using Google classroom in science courses improve science learning?" was achieved by comparing test grades from the non-treatment unit on ionic bonding to those from the treatment unit on covalent bonding. A total of four Chemistry classes were evaluated

involving a total of 48 students; three seniors and 45 juniors. A total of 22 males and 26 females were in the group.

Statistics for the non-treatment unit included a mean of 83.58% with a median score of 83.5%. Scores exhibited a spread of 35.25 percentage points with a high of 100% to a low of 64.75%. Treatment unit statistics included a mean of 83.73% with a median of 86.4% (Figure 6). The spread for the treatment unit was 52.6 points with a high of 105% (5 extra credit points offered) to a low of 52.4%. Although, the 0.15% increase in mean was not large the 2.9% increase in the median score was more significant. The average gain for students who experienced one was calculated to be 10.24 percentage points, representing a one letter grade improvement. However, three students experienced an improvement of two letter grades.

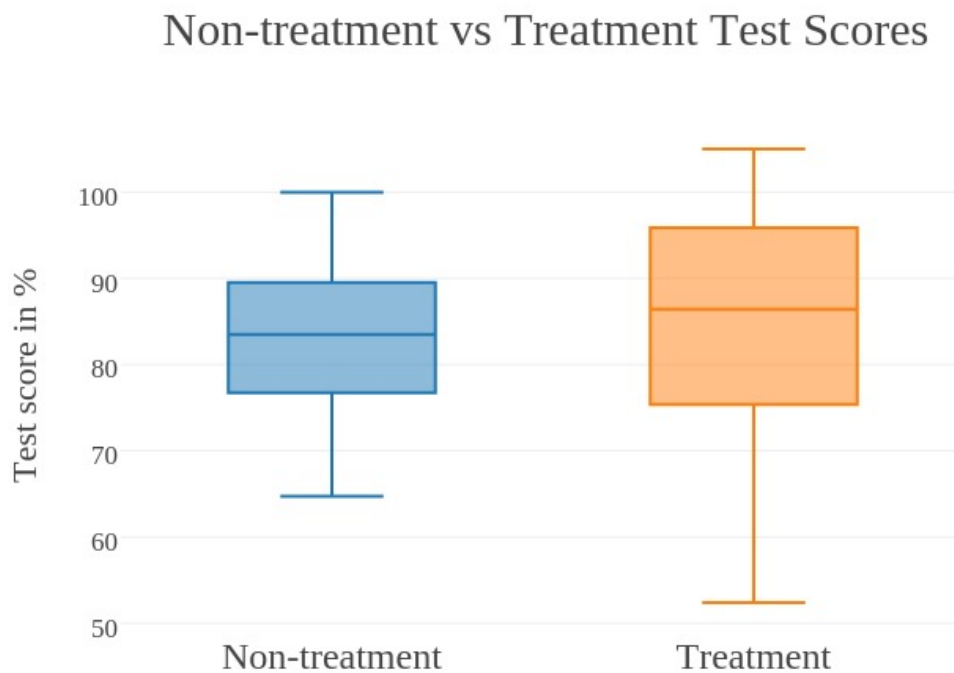


Figure 6. Non-treatment vs. treatment test scores, ($N=48$).

Overall, 52.1% of students increased their test score on the post-treatment unit with 57.7% of females achieving an increase compared to 45.5% of the males. The three largest increases of 27.6%, 21.7% and 21.6% were all achieved by females, the largest by an ELL foreign exchange student, however, the three largest losses were also by females. The largest gain by a male student was 19.9% while the largest loss was 21.9%.

Paired t-test calculations indicated a $t=0.0775$ with a $P\text{-value}=0.9385$ (df47) indicating no statistical significance in the difference between the two sets of test scores. Further statistical analysis using a Cohen's $d=0.01234$ indicated a small effect size. This did not indicate any statistically significant change from the non-treatment test scores to the treatment scores.

Student interviews indicated they enjoyed the new approach to learning. Two students indicated it was “easier to watch a video at home than in class, I get distracted easy in class due to Zach”. Another student stated “I got so much more out of the practice problems when I did them in class instead of at home.” All students interviewed indicated the class discussions regarding processes for working out the various structures and problems were more beneficial than just reviewing the answers in class. Half of the interviewed students ($N=6$) indicated they “wish(ed) we had learned this way all year long.”

Evaluation of the second sub question, “How will student adherence to due dates be effected when assignments are expected to be submitted digitally vs. on paper?” involved data collected from surveys, interviews and statistics representing actual compliance by students. In the pre-survey from the general population of the school,

75% of students overwhelmingly agreed that having a Chromebook would improve their ability to meet assignment due dates in all classes with this number increasing to 80.9% on the post-survey. However, perception of their ability to do so specifically in Science class was 61.5% pre-survey and down to 52.4% post-survey, much lower than on the question regarding for all classes.

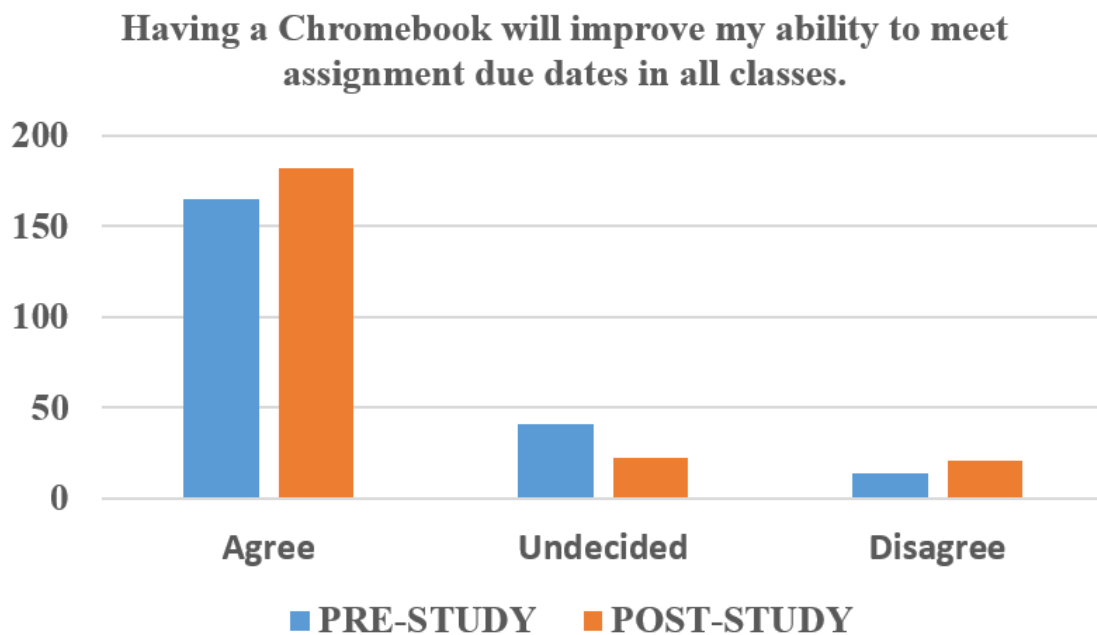


Figure 7. Assignment due dates, (Pre-study N=216, Post-study N=225).

Student comments from the survey indicated that being able to “submit assignments from home helps” and “it lets me know when stuff is due.” Many students felt it also “helps me stay organized” and it “grants me access 24/7.” Most importantly to one student “I can turn it in as soon as it’s done, instead of remembering to do it in class the next day.”

However, comments also indicated some explanations as to why the Chromebooks were not beneficial for meeting due dates. Several students stated they do

not have internet access at home which limits their ability to check due dates and to submit assignments as soon as they are completed. Other students indicated that they don't use the Chromebooks in science class.

I noted several times during my personal journaling that the Chromebooks were cumbersome and problematic for chemistry assignments when chemistry equations, drawings (Lewis structures) and math problems were involved. However, it was also noted on three separate entries involving paper assignments that student excuses primarily indicated that either they "lost my paper" or "forgot because there was no reminder on classroom."

Evaluation of actual student compliance for sub-question two was achieved by collecting data from a subset of 11 students. During the 2015-2016 academic year they were responsible for 54 assignments common to each of them totaling 594 total due in chemistry. Overall, they were late with 4.0% (24) with 3.9% (23) missing altogether for a total of 7.9% of their assignments. Six of the 11 students had 5 assignments with adherence problems, with an average of two late and three missing altogether, while no students had zero assignments with an adherence problem. When expected to submit assignments using the Chromebooks and the Google Classroom application during the 2016-2017 year in physics class, the same students had 13 assignments in common for a total of 143. A total of 4.9% (7) were late with 6.3% (9) missing altogether for a total of 11.2% (Figure 8). This was represented by four students with no adherence issues, two students with one assignment turned in late and five students with more than one assignment late or missing. Interestingly, two of these eleven students were interviewed

with one estimating her due date compliance rate as 75% or better and the other estimating a 90% or better compliance rate. My journal notations indicated this occurred most often near times when students had upcoming external academic activities related to advanced placement courses or Beta Club.

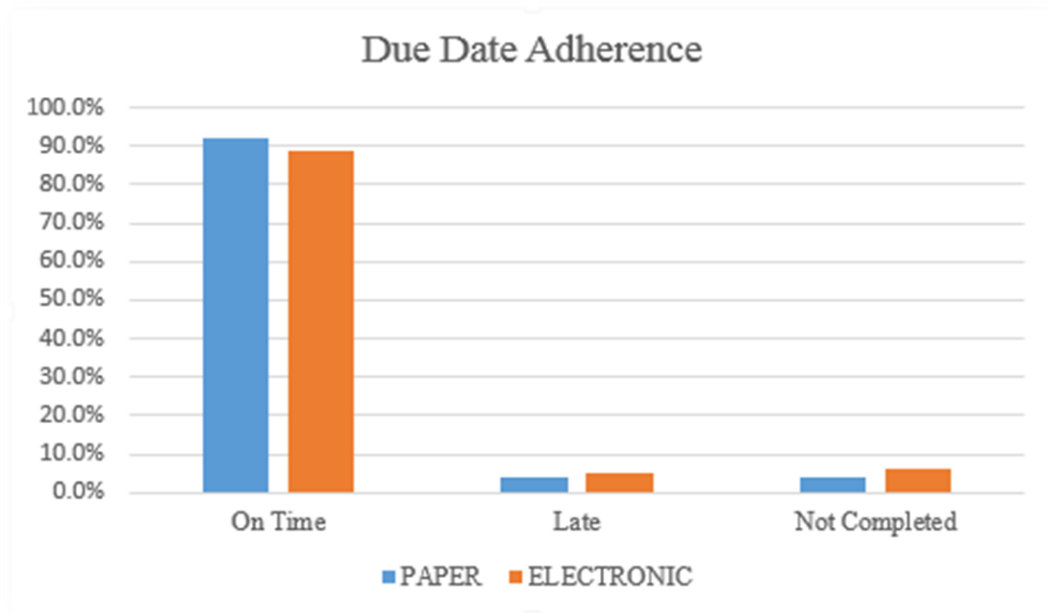


Figure 8. Due date adherence-paper vs. electronic submission, ($N=11$).

Students interviewed during the study indicated in 100% of the discussions that the reminders provided by Google Classroom on the Chromebooks was a very important factor in getting their assignments completed on time. One student stated “I get irritated when it says late-I hate for it to say late”, when asked how “having the Chromebook improves your ability to complete assignments on time.”

Survey information compiled for research sub-question four, the Chromebook’s affect on their attention during class, indicated that students believed having a

Chromebook would not distract them significantly but instead would improve their ability to pay attention in class.

During the pre-study survey 46.3% agreed that their ability to pay attention would improve while 45.3% agreed post-study that it had improved their attention (Figure 9).

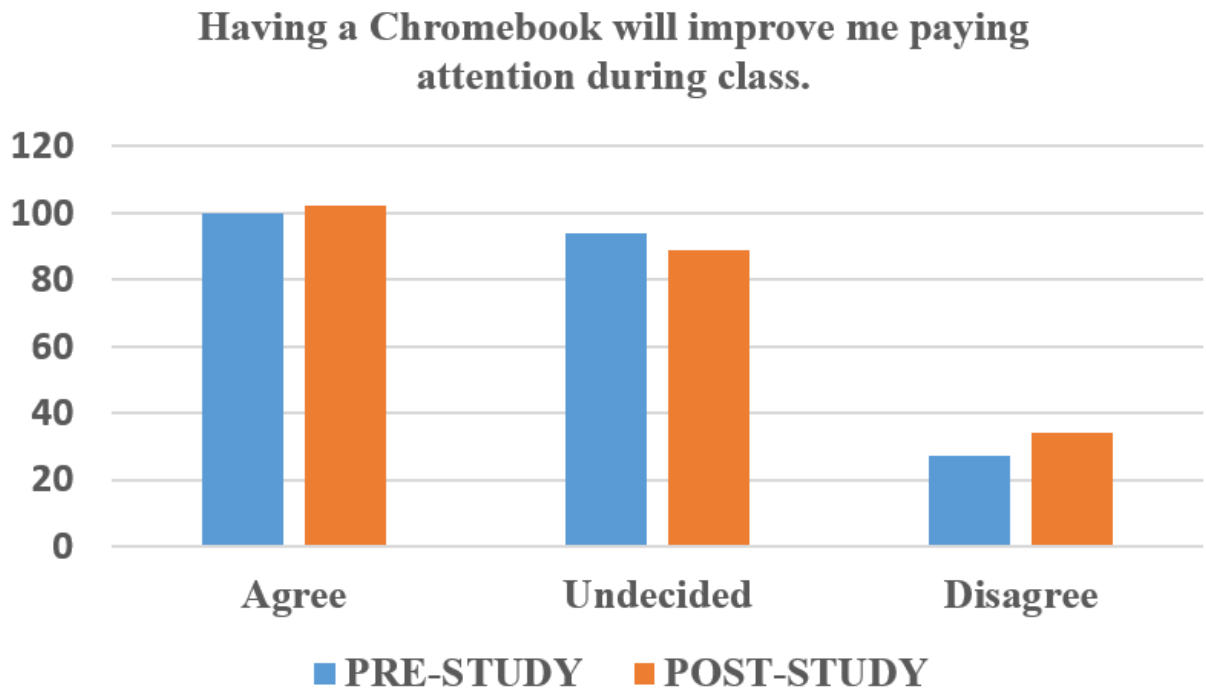


Figure 9. Improved attention, (Pre-study $N=216$, Post-study $N=225$).

However, when given the statement “having a Chromebook will cause me to not pay attention in class” 75% indicated pre-study that it would not while 80.9% post-study said it would not (Appendix E, Figure 10).

When asked to rate how often the Chromebook caused them to not pay attention during class, 84.3% said on the pre-study survey that this happened less than 60% of the

time, while 89.8% said post-study that it happened. Less than 10% of students indicated being distracted more than 80% of the time (Figure 11).

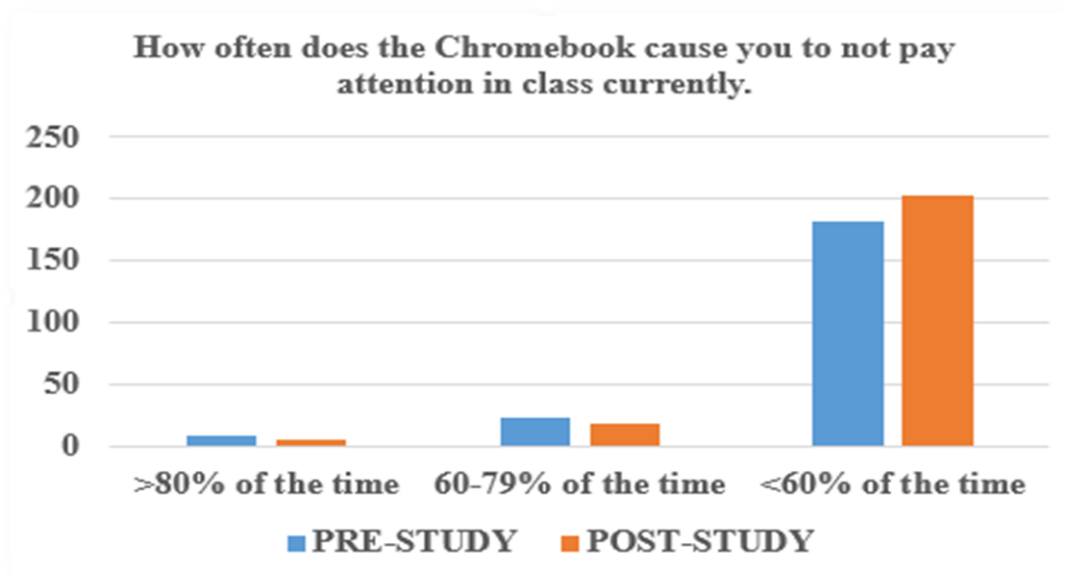


Figure 11. Perceived distraction rate, (Pre-Study $N=216$, Post-Study $N=225$).

Observations by an impartial observer indicated otherwise. During each of three days of observations 42 of the 48 chemistry students were present. During the class time when Chromebooks were in use statistics varied. The first day of observation students were using the Chromebooks to take notes. This was not the norm in the chemistry class since inserting equations and symbols could present problems. However, the topic on day one was one that would not include these issues. The observer noted that by 12 minutes into the lecture and discussion students were becoming distracted. At that time 7 or 16.7% ($N=42$) were involved in work for another course with 14 or 33.4% distracted by 18 minutes into the lecture. At the 18 minute point, 10 or 23.8% were completing work for another course while 4 or 9.5% were exploring other websites. These numbers remained steady until the 24 minute mark at which time 21 or 50% of the students were

distracted. All but 6 or 14.3% of the students were working on other assignments while those six were on unrelated websites.

Day two of the observations showed improved statistics. The activity on day two was use of a simulated lab exercise during which students were to complete a worksheet with the data they observed. Again 42 of the 48 chemistry students were present during the four classes. The activity lasted for approximately 30 minutes with all 42 or 100% ($N=42$) of the students still engaged at the 21 minute mark. However, at the 24 minute check 21 or 50% of the students were exploring unrelated websites, but did have their worksheet on the simulated lab completed. By the 27 minute mark 31 or 73.8% had their work completed and were exploring unrelated websites with all 42 or 100% having their work completed and on other websites at the completion of 30 minutes.

The third observation day showed different patterns of distraction. Students had 30 minutes to conduct research and record information on a group of elements assigned to each group with three people per group. They were to place the information on cards for each element then organize them according to different patterns they noted in the information. Again, 42 of 48 chemistry students were present on this day. The observer noted after nine minutes that 42 or 100% ($N=42$) of the students were working on task on their Chromebooks, however, after 12 minutes 10 or 23.8% were noted to be exploring unrelated websites. Their work was not complete and I also noted numerous students were distracted. At the 18 minute observation 15 or 35.7% were on unrelated websites with work not completed. No students were observed working on assignments for another class at this point. Finally, after 27 minutes of observation, fully 100% of

students were exploring unrelated websites. The activity was stopped and I questioned what had happened. The majority of students indicated they did not understand some of the data they were to collect on the elements and found data searching to be “boring”, consequently, many decided to let their partners do the work and go to something else. The lesson was discontinued at that point and revisited in a different format the following day.

The final question of the study “How will using Google classroom and applications for assignments impact the teacher’s ability to provide adequate feedback on assignments?” was evaluated based on my teacher journal. I noted some interesting observations. When evaluating student work on paper on four assignments I noted in the journal, the average time to get feedback to the student was three days. Typically this involved copies for 48 students, usually multiple pages of paper per student, all of which I carried home for two nights to complete at home. At the time of each of the assignments for chemistry, I was also carrying home paper assignments for 14 physics and 6 advanced chemistry students as well. This added considerable weight and bulk to my briefcase. After grading all papers, I would then enter grades in a gradebook prior to returning the work to the students.

However, when evaluating the five assignments during the treatment unit in chemistry that were submitted digitally, I noted some changes. Since everything was accessible on the Chromebook, I was not carrying additional weight and bulk each night. I also found that 80% of those assignments were completely evaluated the same day I received them from the student. Also noted, I released the grade and the feedback to the

students immediately 90% of the time, only holding back ones that I wanted to discuss with the students individually. The grades were still accessible to me on the classroom application and I did not have to record the grades prior to returning the students work to them. Student comments I noted included “I paid more attention to my grade when I got it back the next day instead of three days later.”

The observations made during the study indicated the majority of students were excited about the Chromebook program and the possibilities it provided. However statistically, using the devices to flip the chemistry classroom for one unit, there were no changes in student learning when this was done, although, students did enjoy the new approach to learning. Individual students who showed gains in learning, showed large gains, however, based on a very small pool of students, their ability to meet due dates for assignments did not improve with the use of the devices, although student perceptions indicated they thought it did. Distraction rates were higher than student self-perceptions indicated, dependent on the situation.

INTERPRETATION AND CONCLUSION

Overall some interesting observations developed from the study. The primary study question was “how will a one to one Chromebook program impact student learning, skills and attitudes towards school and science?” Student enthusiasm and optimism about the Chromebook program started at 80.1% of responding students ($N=216$) at the introduction of the program but fell to 66.7% ($N=225$) by the end of the study period in March of 2017. Although students increased in the number who felt the program was helping to prepare them for college from 74.7% to 75.1%, there was a slight decrease in

the number of students who agreed that the school was helping them by starting the program from 84.6% to 79.1%. Additionally there was a decrease in the number of students who agreed that the program was a positive addition to the curriculum at RVHS (from 86.2% to 77.3%). Some questions have been raised since the implementation of this one-to-one Chromebook program, as to why this negative trend occurred.

One possibility is that during the last month of the study (March 2017), the principal implemented use of the Second Sight application to monitor student internet activity. Many students were offended by this and felt that their rights were being violated. However, all students had agreed to being monitored when they signed a Terms of Use Agreement before receiving their individual devices. This potentially altered their overall perceptions of the benefits of the program.

A second possibility that arose during interviews and the survey comments indicated that there was no consistency in the manner the Chromebooks were used by teachers. Several teachers in math and science found them cumbersome and inconvenient for assignment submission and note taking due to the previously mentioned issues of math functions and equations. Consequently, teachers complained of students not paying attention if the devices were out during class and would not allow students to use them except for viewing supplemental videos or specific learning programs.

The first sub-question regarding implementing a flipped classroom showed varying results. The mean of the test scores only increased by 0.15% points, but the median increased 2.9% points. Although mean test scores on the treatment unit did not significantly increase, the increase in median score was a positive indicator of possible

benefits of a flipped format in Chemistry. With 52.1% of students achieving an increased test score on the treatment unit test with the average increase being 10.24 percentage points (one letter grade) and three students increasing by two letter grades (> 20 percentage points), I consider this to be an effective method for many of my students.

My journal notations indicated that the majority of students who experienced a decrease were preparing to attend the state convention for Beta Club on the day after the treatment unit test. Indications were that these students were more interested in performing well in the convention activities, than on a chemistry test as evidenced by one student stating “there will be more tests this year but convention doesn’t come again till next March.”

There were also indications that females may have benefited more from the flipped learning format than males since the largest gains were by females. I would like to conduct future studies to include additional data compilation in the area of female vs. male gains in learning in the flipped classroom.

I made the assumption prior to this study that test scores would increase. Students also made this assumption. The majority of students believed that the one-to-one Chromebook program would be a positive addition to curriculum, would improve their study skills, would improve their learning in Science and other classes and would not distract them in the classroom. The quantitative research indicates that although the mean test score post treatment did not statistically improve, the median did. Obviously if the middle of the 48 scores was higher on the post-treatment unit test then several

students achieved a higher score. The mean did not improve because the students who declined showed a large decline as compared to the improvement by the other students.

Another topic that was researched through the course of this study was due date adherence through paper versus digital submission via the Chromebooks. Student's perceptions were that their due date adherence would increase with 80.9% indicating this post-study. In reality, due date adherence actually declined on all aspects in the small pool of students studied. Submissions on paper indicated a total of 7.9% of assignments being late or missing, while 11.2% of digital submissions were late or missing. The percentage of assignments turned in on time significantly decreased, while the assignments turned in late or not completed increased although students credited the due date reminders that Google Classroom provided as helping to improve their compliance. I believed from my observations that there was a correlation between the rapid approach of graduation time and the data collection period for this question. A better indicator of due date compliance would be a study involving students who are not in their senior year since these students often get distracted from their studies due to senior activities.

Regarding the investigation of whether the Chromebooks provided a distraction from learning data was more widely varied but easier to interpret. The number of students who felt the Chromebook would not be a distraction increased from 75% to 80.9%. At the end of the study 89.8% of students said the Chromebooks distracted them less than 60% of the time. During the three days of observations, the actual percentages of students distracted varied and involved different explanations for the distractions. Day one showed an average of 33.3% of students doing other assignments or exploring

unrelated websites instead of taking notes during a lecture. Day three showed 61.9% of students on average viewing unrelated websites instead of performing internet research for an assignment. Day two was the most successful experience with 100% of students staying engaged until their work was completed. There was a definite correlation between the type of work expected of the students and how easily distracted they became. When the assignment involved simulated labs there was more engagement, presumably because it more resembled the computer games the students were accustomed to playing at home.

Finally, in regards to the teacher's ability to provide adequate feedback to students there was a vast improvement. Turnaround time dropped from an average of three days when paper assignments were involved to one day when digital submission and feedback occurred. This resulted in less physical labor to transport assignments to and from home for evaluation in the evenings and less stress since grades were completed and returned in a shorter amount of time. Student satisfaction regarding the impact of the feedback provided improved resulting in less conflict between me and the student regarding that feedback.

Overall, the study provided supporting evidence of several benefits from the use of Chromebooks in the science classroom. Even though evidence of improved learning was not proven through statistical studies, enough students showed improvement to support the use of a flipped methodology for teaching in the science classroom. Also, the improved teacher and student satisfaction with the ability to provide prompt feedback on assignments digitally support its continued use, however, more study, observation and

thought needs to be performed regarding assignment due dates and submissions, as well as the patterns of distraction caused by the Chromebooks.

VALUE

As someone who learned a lot and well from the traditional teaching approach that existed in the 1970's, I have struggled during my seven years of teaching with what is best for today's students. Using a PowerPoint presentation and presenting the content information by standing in front of a classroom full of students talking about the main points and the pictures is easy. It takes very little time to prepare for and allows me to tell the kids what they need to know. However, I have seen many times that my students do not retain what I tell them, even with practice as homework.

Why doesn't this work anymore? For starters, many of the kids don't or won't do the homework because of other factors. Some don't want to be in school and will not do anything associated with school once they walk out of the building each day. Some are not convinced of the adage that practice makes perfect, especially when it comes to learning and the necessity of homework. Many believe that their sports involvement will lead to big opportunities post high school and others are too busy working to help support their families due to various tragic factors.

Other students have been told over the years that they are kinesthetic learners and have taken this to mean that this is the only way they can learn information, consequently not even trying to learn another way. Being lectured to while sitting does not stimulate a person and many times puts students to sleep.

Even with recognizing these factors, it was difficult to determine what would give my students the best education while being a method that I was comfortable with. Even though I struggled with this research project, it has convinced me that flipping my classroom is worth trying on a much larger scale, particularly after students commenting that they wished we had used this format all year long. Why am I interested?

Flipping would potentially solve some problems. Watching videos at home doesn't require much effort. Students can simply watch and take notes if they choose. They often retain information from the videos that they don't realize. They also have the videos available for viewing again if needed unlike a lecture that when finished cannot be viewed again.

It also solves the problem of students getting frustrated with trying to work a problem at home and quitting due to frustration. They can now get assistance in the classroom same day, instead of waiting for the next day. Since there is never enough time in class to do everything, this drastically increases the time available for teaching through doing. Students also get the benefit of more than just my help, they also get help from their peers which helps teach teamwork and content skills.

Although there will be more class preparation time upfront with preparing my own videos, once completed, they can be stored and re-watched digitally. It will allow me more time to truly interact with my students while they are learning, rather than lecturing or "preaching" to them.

Observing student gains in learning during the treatment unit of this study has helped restore the excitement and eagerness I felt for a new career seven years ago, when I left medicine for teaching.

REFERENCES CITED

- Bostic, Edith J., Edwards, Timothy R., (2016). *Inspiring Change Agents Through Technology*. ProQuest. Morehead State University, Morehead, Kentucky.
- Cooper, Harris, Valentine, Jeffrey C., (2001). Using Research to Answer Practical Questions About Homework, *Educational Psychologist*, 36:3, 143-153. Retrieved April 19, 2017, from http://dx.doi.org/10.1207/S15326985EP3603_1
- Lage, M. J., Platt, G. J. Treglia, M., (2000). Inverting the Classroom: A Gateway to Creating an Inclusive Learning Environmenet. *The Journal of Economic Education*, 31:1, 30-43.
- Leo, J., Puzio, K., (2016) Flipped Instruction in a High School Science Classroom, *The Journal of Science and Educational Technology*, 25, 775-781.
- Lux, N.J., Bangert, A., McGeehan, M., Will-Dubyak, K., Watson, R. (2015) The Influence of Class Sets of Mobile Devices on Student Learning: *Research Highlights in Technology and Teachers Education 2015*. Waynesville, NC: Association for the Advancement of Computing in Education.
- Moore, T. L. (2012). *Student Directed Inquiry: Virtual vs. Physical*. (Unpublished Professional Paper). Youngstown State University, Youngstown, Ohio.
- Olakanmi, E. E., (2017). The Effects of a Flipped Classroom Model of Instruction on Students' Performance and Attitudes Towards Chemistry. *Journal of Science Education and Technology*, 26:127-137.
- Schultz, D., Duffield, S., Rasmussen, S., Wageman, J., (2014) Effects of the Flipped Classroom Model on Student Performance for Advanced Placement High School Chemistry Students, *Journal of Chemical Education*, 91(9), 1334-1339.
- Sparks, S. D., (2011). Schools "Flip" for Lesson Model Promoted by Khan Academy. *Education Week*, 31 (S), 12-14.
- Tucker, Dina M., (2013) *Investigating the Efficacy of a Flipped Science Classroom Model*. Montana State University, Bozeman, Montana.
- Vanderkam. J., (2013). "Blended Learning a win-win: Combined in-person and online teaching helps students, *USA Today*. Retrieved December 8, 2015 from <http://search.ebscohost.com/login.aspx?direct=true&db=mih&AN=JOE044390273113&site=eds-live&authtype=cookie,ip,custuid&custid=infohio>.
- Xu, J., (2011). Homework Completion at the Secondary School Level: A Multilevel Analysis. *The Journal of Educational Research*, 104:3, 171-182.

Zadok, Y., Tal, H. T. (2015) Engaging Students in Class Through Mobile Technologies- Implications for the Learning Process and Student Satisfaction: *Research Highlights In Technology and Teachers Education 2015*. Waynesville, NC: Association for the Advancement of Computing in Education.

APPENDICES

APPENDIX A

BOSTIC: PRE-STUDY SURVEY

Participation in this research study is voluntary.
Participation or non-participation will not affect a student's grade or class standing in any way.

1=strongly agree 2=agree 3=undecided 4=disagree 5=strongly disagree

1. I am enjoying this school year.

1 2 3 4 5

Why did you answer the above question in the way you did?

2. I am excited about the new Chromebook program at my school.

1 2 3 4 5

3. I already knew how to use a Chromebook computer prior to implementation of this program.

1 2 3 4 5

Where did you learn to use it?

4. I believe the school is helping me by starting the Chromebook program.

1 2 3 4 5

5. Having a Chromebook will prepare me for college.

1 2 3 4 5

6. I was familiar with Google Classroom prior to the start of this school year.

1 2 3 4 5

Where did you become familiar with it?

7. Having a Chromebook will be beneficial to my learning in all classes.

1 2 3 4 5

Can you give me some specific examples?

8. Having a Chromebook will be beneficial in science class.

1 2 3 4 5

9. Having experience with a personal computing device will prepare me for a career.

1 2 3 4 5

10. I am enjoying science class.

1 2 3 4 5

What do you enjoy the most? The least?

11. Having a Chromebook will improve my study skills.

1 2 3 4 5

How will the Chromebook improve your study skills?

12. Having a Chromebook will improve my following assignment due dates in all classes.

1 2 3 4 5

Why did you answer the above question in the way you did?

13. Having a Chromebook will improve my adherence to assignment due dates in science class.

1 2 3 4 5

How will the Chromebook improve your adherence to due dates?

14. Having a Chromebook will improve my laboratory report writing skills.

1 2 3 4 5

How will the Chromebook improve your laboratory report writing skills?

15. Having a Chromebook will improve my note-taking abilities in class.

1 2 3 4 5

16. Having a Chromebook will improve my note-taking abilities in science class

1 2 3 4 5

How will the Chromebook improve your note-taking abilities in science class?

17. Having a Chromebook will cause me to be distracted in class.

1 2 3 4 5

How will the Chromebook cause you to be distracted in class?

18. Having a Chromebook will improve my attention span in class.

1 2 3 4 5

How will the Chromebook improve your attention span in class?

19. The Chromebook program is a positive addition to our schools curriculum.

1 2 3 4 5

Why is the program a positive addition to our schools curriculum?

Any other thoughts on the Chromebook program not addressed in the above questions.

APPENDIX B

BOSTIC: POST-STUDY SURVEY

Participation in this research study is voluntary.
Participation or non-participation will not affect a student's grade or class standing in any way.

1=strongly agree 2=agree 3=undecided 4=disagree 5=strongly disagree

1. I have enjoyed this school year.

1 2 3 4 5

2. I am still excited about the Chromebook program.

1 2 3 4 5

3. What continues to excite you about the Chromebook program?

4. I have continued to gain skills in using the Chromebook and the applications available.

1 2 3 4 5

5. I continue to believe the school is helping me by having the Chromebook program.

1 2 3 4 5

6. How is having the Chromebook helping you?

7. Using the Chromebooks continues to prepare me for college.

1 2 3 4 5

8. How does the Chromebook prepare you for college?

9. I am comfortable with using Google Classroom.

1 2 3 4 5

10. Having the Chromebook has benefited my learning in all my classes.

1 2 3 4 5

11. How has the Chromebook benefited your learning in all classes?

12. Having a Chromebook has benefited by learning in science class.

1 2 3 4 5

13. How has the Chromebook benefited your learning in science class?

14. Having experience with a personal computer is helping prepare me for a career.

1 2 3 4 5

15. What grade are you in this year?

9th 10th 11th 12th

16. Having the Chromebook has improved my study skills.

1 2 3 4 5

17. How has it specifically improved your study skills?

18. Having a Chromebook has improved my ability to meet due dates for my assignments.

1 2 3 4 5

19. How has the Chromebook improved you meeting due dates?

20. Having a Chromebook has improved my ability to meet due dates in science class.

1 2 3 4 5

21. How has the Chromebook improved your ability to meet due dates in science class over your other classes?

22. Having a Chromebook has improved my note-taking skills in all my classes.

1 2 3 4 5

23. How has the Chromebook improved your note taking skills?

24. Having the Chromebook has improved my note-taking abilities in my science class

1 2 3 4 5

25. How have your note taking skills improved in science class differently than other classes?

26. Having the Chromebook has caused me to NOT pay attention during class.

1 2 3 4 5

27. How often has the Chromebook caused you to not pay attention during class this year?

Greater than 90% of the time
80-90% of the time
70-80 % of the time
60-70% of the time
Less than 60% of the time

28. How does the Chromebook cause you to not pay attention during class?

29. Having the Chromebook has improved me paying attention during class.

1 2 3 4 5

30. How has the Chromebook improved you paying attention during class?

31. The Chromebook program continues to be a positive addition to our schools curriculum.

1 2 3 4 5

APPENDIX C

BOSTIC: STUDY INTERVIEW QUESTIONS

Participation in this research study is voluntary.

Participation or non-participation will not affect a student's grade or class standing in any way.

1. What do you most enjoy about being in school?
2. What do you like or dislike about Physics/Advanced Chemistry?
 - a. Why do you like or dislike that?
3. Are you more motivated to succeed in a class that you like?
 - a. Why or why not?
 - b. What motivates you to be involved in class?
4. What contributes to your success in science class?
 - a. Can you give me an example?
5. Is completing assignments for science class important to you?
 - a. Why or why not?
 - b. Why don't you sometimes get them finished?
6. How often would you say you meet assignment deadlines?
7. Why do you feel meeting assignment deadlines is important?
8. Under what circumstances do you NOT meet assignment deadlines?
9. What would improve your ability to meet assignment deadlines?
10. How will having the Chromebook improve your interest in completing assignments on time?
11. How will having the Chromebook improve your ability to complete assignments on time?
12. How quickly do you learn to use new technology?
13. How will having to learn the technology influence your adherence to due dates?

Is there anything else you might tell me that might help me with my research on the effectiveness of Chrome books?

APPENDIX D
IRB APPROVAL



INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

960 Technology Blvd. Room 127
 c/o Immunology & Infectious Diseases
 Montana State University
 Bozeman, MT 59718
 Telephone: 406-994-6783
 FAX: 406-994-4303
 E-mail: cherylj@montana.edu

Chair: Mark Quinn
 406-994-5721
 mquinn@montana.edu
 Administrator:
 Cheryl Johnson
 406-994-6783
 cherylj@montana.edu

MEMORANDUM

TO: Lenora Bostic and Walter Woolbaugh
FROM: Mark Quinn, Chair *Mark Quinn cy*
DATE: November 20, 2015
RE: "Chrombebooks as Learning Tools in the Science Classroom" [LB112015-EX]

The above research, described in your submission of November 20, 2015, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- X (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
- X (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.
- _____ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
- _____ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.
- _____ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.
- _____ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX E
ADDITIONAL FIGURES

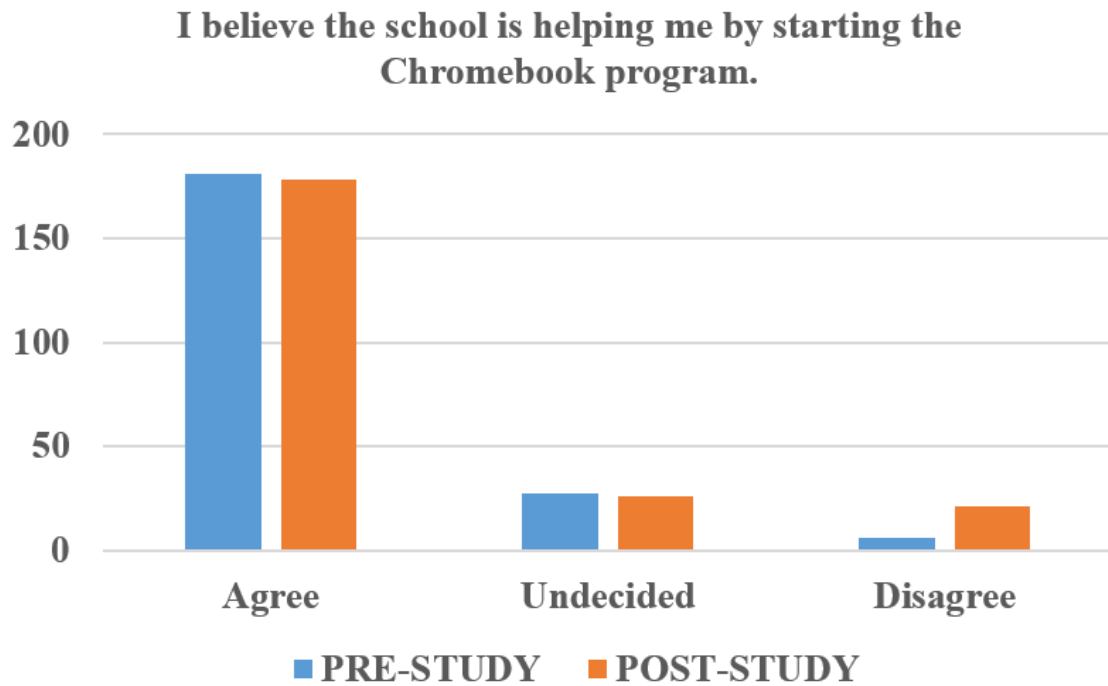


Figure 2. School helping with program, (Pre-study $N=216$, Post-study $N=225$).

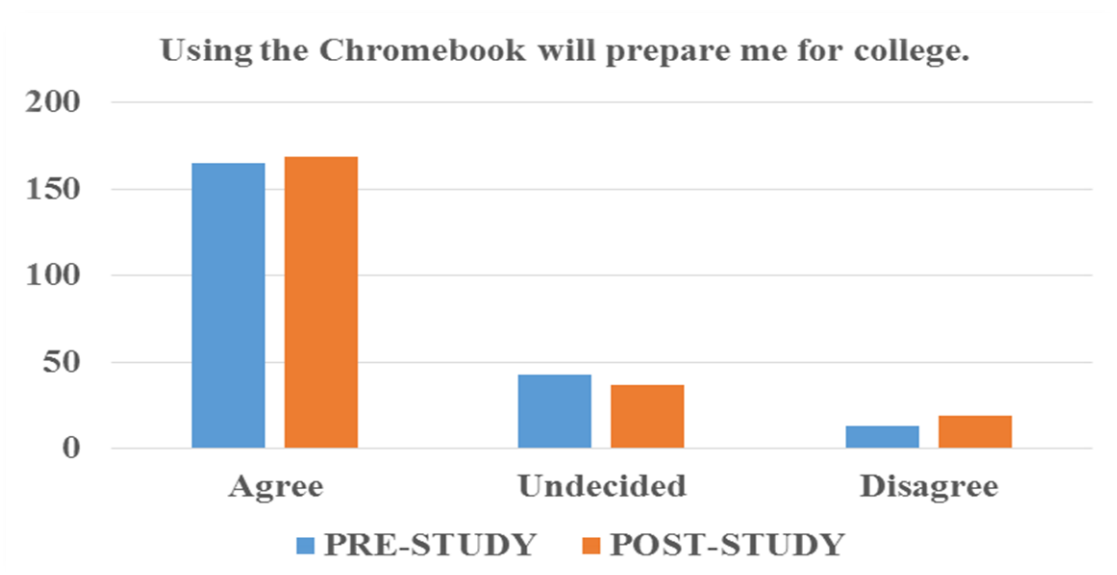


Figure 3. Preparation for college, (Pre-study $N=216$, Post-study $N=225$).

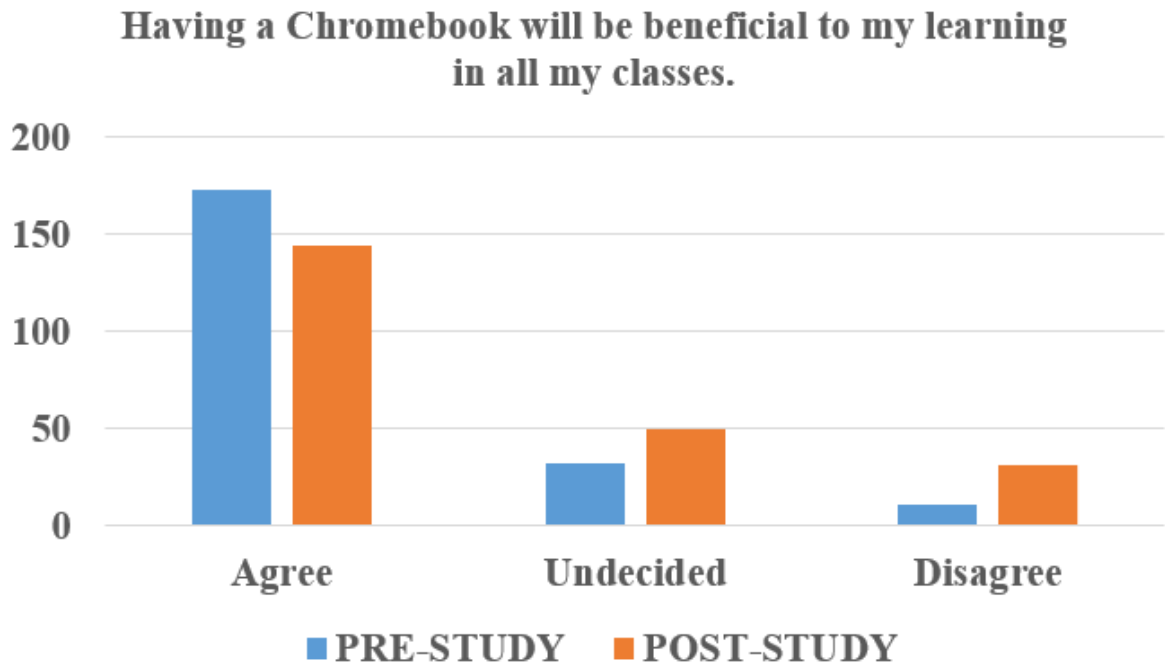


Figure 4. Benefit to learning, (Pre-study N=216, Post-study N=225).

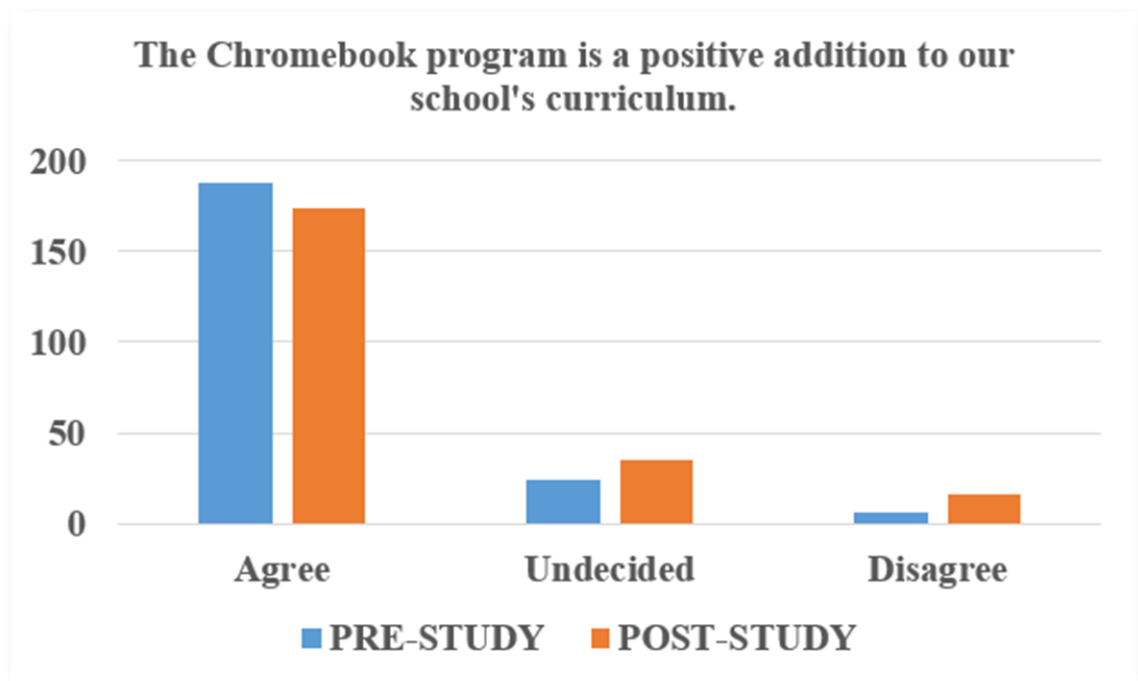


Figure 5. Positive addition to curriculum, (Pre-study N=216, Post-study N=225).

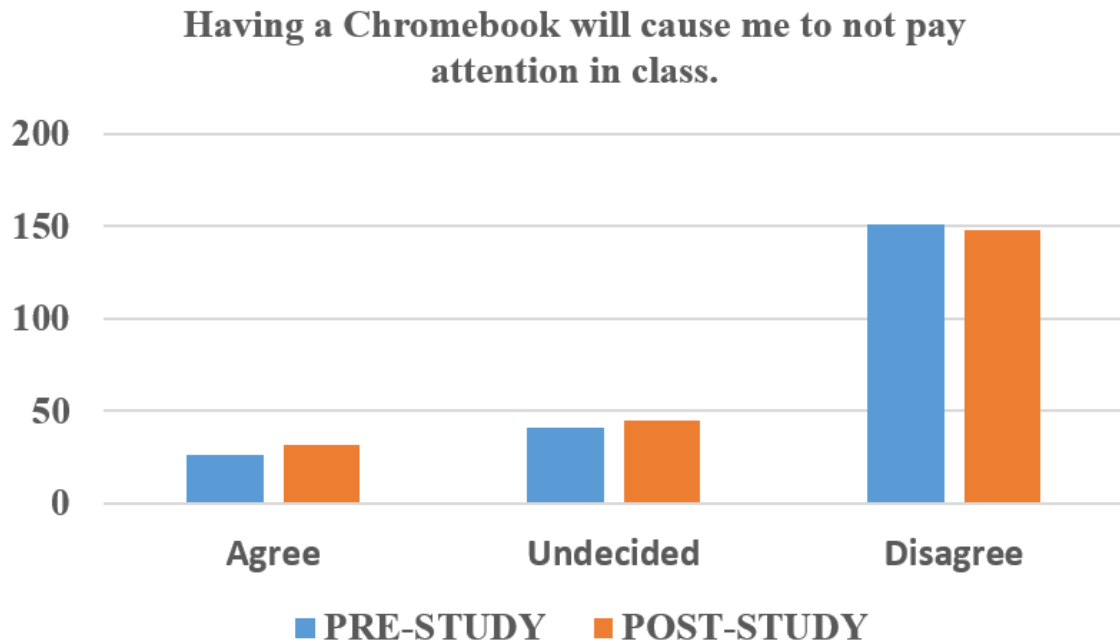


Figure 10. Not paying attention, (Pre-study $N=216$, Post-study $N=225$).

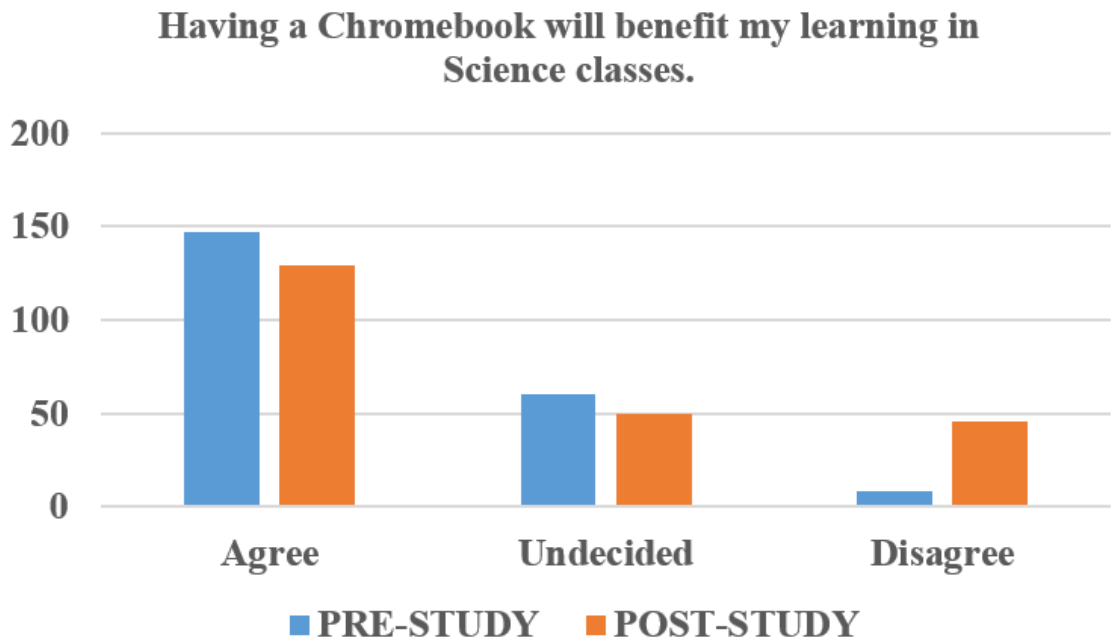


Figure 12. Benefit to science class learning, (Pre-study $N=216$, Post-Study $N=225$).

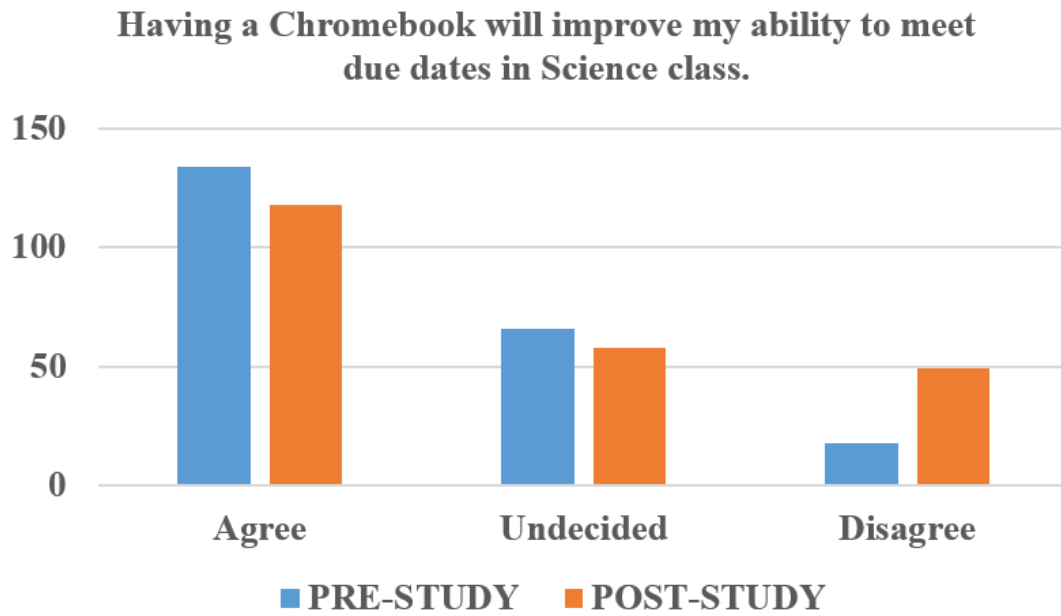


Figure 13. Science assignment due dates, (Pre-study $N=216$, Post-study $N=225$).

APPENDIX F
STUDENT DISTRACTION TALLY SHEET

	ON TASK	OTHER ASSIGNMENT	UNRELATED
--	---------	------------------	-----------

3			
---	--	--	--

6			
---	--	--	--

9			
---	--	--	--

12			
----	--	--	--

15			
----	--	--	--

18			
----	--	--	--

21			
----	--	--	--

24			
----	--	--	--

27			
----	--	--	--

30			
----	--	--	--